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# Financial syndication and R&D

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**Abstract**

This paper provides a contractual foundation that solves a class of commitment problems in R&D financing and explains why large corporations having sufficient resources to finance R&D projects alone often choose to finance them through syndicated venture capital.


*Keywords:* Commitment problem; Financial syndication; R&D

*JEL classification:* G32; O31

It is well documented that idea-rich small firms financed by syndicated venture capital (VC) originate a disproportionate large-share of innovations, particularly in high-tech industries. Compared with these small firms, large corporations tend to focus their R&D activities on less uncertain and less novel projects (Scherer, 1992; Lerner, 1994). Moreover, in high-tech sectors a large corporation usually chooses to finance highly uncertain R&D projects through syndicated VC even when these projects are very relevant to its core business, and it can afford to finance them alone, i.e. to financially integrate them with itself.

This paper provides a theory to explain the above phenomena. We start with an observation that the uncertainty associated with an R&D project can be reduced when the project is carried out and thus ex-post selection is more effective than ex-ante selection. However, ex-post screening requires a commitment so that a bad project will be abandoned. We show that syndicated financing can be deployed as a commitment device to terminate bad projects timely. With financial integration, however, a large firm with sufficient internal funds may lose this commitment capacity. Moreover, the more uncertain is an R&D project, the higher are the costs of integration.

Our theory is built upon Dewatripont–Maskin model (1995) on a centralized economy's

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commitment problem. We extend the model to a market economy where financiers are not liquidity-constrained. This allows us to address the above R&D financing issue, and a broad range of issues in market economies from growth (Huang and Xu, 1999) to financial crisis (Huang and Xu, 2001).

## 1. Model setup

We consider an economy where there are numerous entrepreneurs and large-firms. Each entrepreneur has a new idea for an R&D project, but no wealth to finance it. There is no wealth constraint on the side of a large firm to finance R&D projects. A large-firm can choose to either integrate the project by financing it internally, or to co-finance it with another financier in a syndicate (large-firm and financier are used interchangeably in the paper). Our model has three periods and the discount rate is zero.

We suppose that among all the projects proposed by entrepreneurs, $\lambda$ percentage of them are of a good type and the rest are of a bad type; and that at date 0 all projects are worthy of being financed. A good project requires a total investment of $I_1 + I_2$ and generates a profitable return $\hat{V}$, where $I_t$ is the required investment in period $t$, $I_1$ and $I_2$ are sunk once they are made, and $\hat{V} > I_1 + I_2$. Because a good project will be completed at date 2 regardless of integration or non-integration, we can focus our analysis on the case of bad projects.

A bad project produces nothing after two periods; but it can be reorganized if given one more period of time and an additional investment of $I_3$. We denote the returns from the best possible reorganization strategy generated at date 3 as $V$, and suppose that a bad project is ex ante inefficient but ex post efficient if reorganized by the best strategy, i.e. $I_3 < V < I_2 + I_3$.

With respect to information, we assume that ex-ante the distribution of the types of all projects is common knowledge, but neither the large firms nor the entrepreneurs know precisely each project's type. At date 1, after working on a project for one period the entrepreneur discovers the type of the project, but the financier(s) still do not know its type until date 2 when a good project generates returns. Therefore, at date 2 a decision has to be made by the financier(s) regarding a bad project: either to reorganize it or to liquidate it.

We suppose that an entrepreneur gets a private benefit $b_t$ from working on a project. Specifically, if the entrepreneur quits the project at date 1, he gets a low private benefit, $b_1 > 0$. At date 2, a completed good project generates a private benefit, $b_{2g} > b_1$, to the entrepreneur. A bad project will be liquidated or reorganized at date 2. If it is liquidated, the entrepreneur gets a still lower private benefit $b_{2b}$, where $0 \le b_{2b} < b_1$. If a bad project is refinanced, it will be completed at date 3 and it will generate a private benefit $b_3$ to the entrepreneur and $b_{2g} > b_3 > b_1 > b_{2b} \ge 0$.

Since there are two financiers, $A$ and $B$, in our model, each naturally chooses one best strategy from its own perspective. As a result, there are two strategies to reorganize a bad project during the third period. We assume only one of the strategies can generate a profit ex-post. The selection of the right decision depends on signals $s_A$ and $s_B$, where $s_J \in [\underline{s}, \bar{s}]$, $\underline{s} < \bar{s}$ and $J = A$ or $B$. Here, we suppose that signal $s_J$ can only be observed by financier $J$, who has observed $\bar{s}_J$, after $I_3$ is invested.

We suppose that at date 0 the financier(s) offer a take-it-or-leave-it contract to the entrepreneur. If the contract is signed the financier(s) will invest $I_1$ units of money into the project during period 1, and they will start to observe $\bar{s}_A$ and $\bar{s}_B$.

The following conditions concern how reorganization strategies are related to information $s_A$ and $s_B$.

First, among the two financiers $A$ is specialized in technology $\tilde{A}$, and $B$ is specialized in technology $\tilde{B}$, such that $A$ can only observe $s_A$ and $B$ can only observe $s_B$. Second, the relationship between $A$ and $B$ satisfies the following efficiency condition (1): strategy $b$ makes the project ex-post profitable if the value of signal $s_A$ is higher than the value of $s_B$; and strategy $a$ makes the project ex-post profitable if the value of signal $s_A$ is lower than that of $s_B$. Formally:

$$\begin{cases} V_A^b(s_A, s_B) + V_B^b(s_A, s_B) > I_3 > V_A^a(s_A, s_B) + V_B^a(s_A, s_B), & \text{if } s_A > s_B \\ V_A^b(s_A, s_B) + V_B^b(s_A, s_B) = V_A^a(s_A, s_B) + V_B^a(s_A, s_B) = I_3, & \text{if } s_A = s_B \\ V_A^a(s_A, s_B) + V_B^a(s_A, s_B) > I_3 > V_A^b(s_A, s_B) + V_B^b(s_A, s_B), & \text{if } s_A < s_B \end{cases} \tag{1}$$

where $V_J^j(s_A, s_B)$ is the payoff of the reorganized project enjoyed by large firm $J$ when strategy $j$ is taken, and $j = a$ or $b$ and $J = A$ or $B$.

Moreover, the relationship between $A$ and $B$ satisfies the second efficiency condition (2): the outcome of a wrong strategy is so bad that the expected net payoff of randomizing between the two strategies is worse than liquidation, i.e.:

$$qV^b(s_A, s_B) + (1 - q)\,V^a(s_A, s_B) - I_3 < 0 \tag{2}$$

where, $V^a(s_A, s_B) = V_A^a(s_A, s_B) + V_B^a(s_A, s_B)$, $V^b(s_A, s_B) = V_A^b(s_A, s_B) + V_B^b(s_A, s_B)$ and $q = \Pr(s_A > s_B)$.[1]

Finally, the two co-financiers $A$ and $B$ have a conflict of interest in choosing reorganization strategies. In the case that the value of $s_A$ is higher, it is more beneficial to financier $A$ if the project is reorganized under strategy $a$ than under strategy $b$; and vice versa. This condition implies that financier $J$ has an incentive to use strategy $j$ if its own signal value becomes higher. That is, for any $s^h > s^l$:

$$V_A^a(s_A^h, s_B) - V_A^a(s_A^l, s_B) > V_A^b(s_A^h, s_B) - V_A^b(s_A^l, s_B) > 0 \tag{3}$$

$$V_B^b(s_A, s_B^h) - V_B^b(s_A, s_B^l) > V_B^a(s_A, s_B^h) - V_B^a(s_A, s_B^l) > 0 \tag{4}$$

Given the above conditions, if a project is externally co-financed, ex-post if the co-financiers want to reorganize a bad project, they need to find a scheme to share their private information. Without a loss of generality, this is equivalent to saying that $B$ will buy the private information $s_A$ from $A$ when the price that $B$ has to pay, $T(s_A, s_B)$ (or vice-versa) is not too high.

## 2. Financial syndication vs. financial integration

In this section, we show that financial syndication provides a commitment device to stop bad projects but financial integration does not.

[1] Any randomization based on $q \in [0,1]$ and $q \neq q$ cannot get a better result than (2).

### 2.1. Financial syndication

At date 2, when the two financiers in the syndicate discover that the project is a bad one, they should decide either to liquidate or to reorganize (i.e. the financiers assign a probability of $p$ to refinance the project). If they decide to reorganize the project, they will invest $I_3$. Then signals $s_A$ and $s_B$ are observed by the two financiers, respectively, and they need to decide what reorganization strategy should be selected (i.e. the financiers assign probabilities of $q(s_A,s_B)$ (or $1-q$) to use reorganization strategy $b$ (or $a$). We show that given only financier $J$ is able to observe $s_J$, under conditions (1)–(4) there is no efficient incentive compatible scheme $q(s_A,s_B)$ and $T(s_A,s_B)$ which can induce $J$ to tell the true value of $s_J$.[2] Thus, reorganizing a bad project at date 2 is inefficient and the financiers choose to liquidate it.

**Proposition 1.** *Under syndicated financing, all bad projects are liquidated at date 2.*

**Proof.** We first analyze financier $A$'s incentive problem by fixing $s_B$ at an arbitrary value $s^* \in (0,1)$. Given compensation scheme $T(s_A,s_B)$ and strategy $q(s_A,s_B)$, financier $A$'s incentive compatibility (IC) condition to tell the truth is:

$$\begin{aligned} & q(s_A,s_B)\,V_A^b(s_A,s_B) + (1-q(s_A,s_B))\,V_A^a(s_A,s_B) + T(s_A,s_B) \\ \geq\; & q(\hat{s}_A,s_B)\,V_A^b(s_A,s_B) + (1-q(\hat{s}_A,s_B))\,V_A^a(s_A,s_B) + T(\hat{s}_A,s_B) \end{aligned}$$

where $\hat{s}_A$ is the false report of the signal. Applying the (IC) to both cases $s_A = s_A^h > s^*$ and $s_A = s_A^l < s^*$ and combining them, we have:

$$\begin{aligned} & \left(q\left(s_A^h,s_B\right) - q\left(s_A^l,\, s_B\right)\right)\left(V_A^a\left(s_A^h,s_B\right) - V_A^a\left(s_A^l,s_B\right)\right) \\ \leq\; & \left(q\left(s_A^h,s_B\right) - q\left(s_A^l,\, s_B\right)\right)\left(V_A^b\left(s_A^h,s_B\right) - V_A^b\left(s_A^l,s_B\right)\right) \end{aligned}$$

According to (3), $V_A^a\left(s_A^h,s_B\right) - V_A^a\left(s_A^l,s_B\right) > V_A^b\left(s_A^h,s_B\right) - V_A^b\left(s_A^l,s_B\right) > 0$. Thus, the incentive compatibility implies $q\left(s_A^h,s_B\right) \leq q\left(s_A^l,s_B\right)$, i.e. $q\left(s_A^l,s_B\right)$ should be non-increasing in $s_A$.

However, by (A.1), for any given $s_B$ when $s_A$ increases from $s_A < s_B$ to $s_A > s_B$, for any $q(s_A,s_B) = \bar{q}$, where $\bar{q} \in [0,1)$ is a constant, the efficiency can be improved by increasing $\bar{q}$, i.e. by $\bar{q} + \varepsilon$, where $\varepsilon > 0$. Thus, the efficiency requires $q(s_A,s_B)$ to be non-decreasing in $s_A$.

Therefore, the only possible scheme of $q(s_A,s_B)$ which may satisfy both IC and the efficiency requirement is to keep $q(s_A,s_B)$ constant, i.e. $q(s_A,s_B) = \bar{q}$. It is obvious that for any $\bar{q} \in [0,1]$, reorganization based on any $\bar{q} \neq q = \Pr(s_A > s_B)$ is not better than $q$. However, by (2), a reorganization decision based on $q$ is worse than liquidation. Thus, the probability of liquidation is 1.

The case of financier $B$ can be proven by symmetry. □

The commitment to liquidate bad projects has a deterrence effect on entrepreneurs. Given $b_{2b} < b_1$, an entrepreneur with a bad project will choose to quit once he discovers it is a bad one. To summarize, we have the following result:

**Corollary 1.** *Under syndicated financing, entrepreneurs are induced to stop bad projects at date 1.*

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[2] The approach is inspired by Maskin (1992), which deals with an auction with private information.

### 2.2. Financial integration

Under integration, the large firm will have all the information $s_A$ and $s_B$ and will be able to use this information to choose an ex-post efficient strategy to reorganize the project. Therefore, the firm is not able to commit to terminating a bad project ex-post. As a result, the entrepreneur has no incentives to tell the truth when he at date 1 discovers that his project is a bad one. Given $b_3 > b_1$, the entrepreneur will always choose to continue a bad project after he privately discovers its type.

Proposition 1. (Dewatripont–Maskin) *Under integration, a bad project in financial integration is not revealed by the entrepreneur and it will be re-organized.*

## 3. Conclusion

The following example illustrates how our model would work in the real world. An entrepreneur has a project for a new drug targeting many types of heart diseases. Financier *A* is a large pharmaceutical company specializing in traditional drugs in heart diseases and having knowledge on marketing drugs. Financier *B* is a venture capitalist specializing in related new technology and having knowledge on cost of that technology. Either financier has resources to finance the project alone. If the project is discovered to be a bad one at date 2, available reorganization strategies are: (a) changing the technology; (b) narrowing down the application target while keeping the technology. The efficiency of reorganization depends on the demand for the potential new drug; and the cost of the technology. If the uncertainty of the project is sufficiently high, financier *A*, anticipating that internal financing implies no commitment to liquidate in case of a bad project, would rather form a financial syndicate with *B* for the project.

In fact, many different institutions, including 'main-bank' coordinated financing in Japan, government-coordinated financing in South Korea, and a centralized economy where the government finances all the projects, correspond to our model of integration. Financial syndication also takes other forms, and among them the syndicated loan market is one of the largest and fast growing sources of corporate funding available today (Esty and Megginson, 2001).

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